Methane and Methanotrophs as a Biotechnological Platform

Lori Giver, VP Biological Engineering,
June 24, 2015
Calysta overview

- Founded in May, 2011; Acquired BioProtein A/S in 2014.
- Core IP and expertise in gas fermentation, bioengineering, and product development.
Our Mission

Building a highly profitable company producing food, chemicals, and fuels from methane:

a sustainable, abundant resource that does not compete with the human food chain
Sustainable Methane

• Methane can be captured from anaerobic digestion of many waste streams
  – Municipal Wastewater
  – Landfills
  – Agricultural Activities
  – Manufacturing Activities

• EPA Renewable Fuel Standard now recognizes biogas as a cellulosic and advanced fuel pathway

• Minimal impacts on land and water usage
Biogas is Cellulosic Carbon

New Pathways
This action qualifies the following as cellulosic and advanced fuel pathways under the Renewable Fuels Standards (RFS):

- Compressed natural gas produced from biogas from landfills, municipal wastewater treatment facility digesters, agricultural digesters, and separated MSW digesters
- Liquefied natural gas produced from biogas from landfills, municipal wastewater treatment facility digesters, agricultural digesters, and separated MSW digesters

...coupled with aggressive new rules on allowable methane emissions from landfill and other municipal sources
Unsustainable Sources for Existing Products

Fish feed → Farmed Salmon

Chemicals & Plastics → Consumer Products

Oils and Fatty Alcohols → Detergents
Sustainable Sources for Existing Products

Calysta can replace the supply chain for a wide range of consumer products using sustainable methane sources.
Platform Tech Supports Multiple Products

Methanotrophs & CALYSTA Technology

Methane, Oxygen, Ammonia, Minerals

Protein, Carbohydrates, Nutraceuticals, Lactic Acid, Butanediol, Fatty alcohols, Isoprene, N-Butanol, Succinic Acid, and more...

NUTRITION
CHEMICALS/ENERGY

CALYSTA
Calysta is Active in Two Industry Verticals

**CALYSTA NUTRITION**

- High quality protein for commercial aquaculture and livestock feed
- Sustainable protein to meet a global demand

[www.calystanutrition.com](http://www.calystanutrition.com)

**CALYSTA ENERGY**

- Production of essential building blocks for industrial materials and consumer products
- Collaboration with NatureWorks
- DOE funded project converting biogas to lactic acid

[www.calystaenergy.com](http://www.calystaenergy.com)
Food Security is the Issue of the Future

- By 2050, 9.6B people will demand 75% more protein than currently available

“Our research shows people will spend one-third of any increase in incomes on a more varied high-protein diet.”

- Greg Page, CEO of Cargill

Source:
UN World Population Prospects: The 2012 Revision.
Increased Protein Consumption is Currently Unsustainable

- More than two-thirds of all agricultural land is devoted to growing feed for livestock, while only 8 percent is used to grow food for direct human consumption.

- If the entire world population were to consume as much meat as the Western world does-176 pounds of meat per capita per year- the global land required would be two-thirds more than what is presently used.

Calysta’s single cell protein product provides

- comparable protein content to high-quality fish meal
- minimal impacts on land and water usage
- a source of protein orthogonal to the human food chain
- a safe, validated product already approved for sale

Source:
What is FeedKind?

- High-protein feed produced biologically from methane
  - Bacteria (methanotrophs) metabolize methane as their sole source of carbon and energy, producing amino acids, proteins, and/or carbohydrates depending on process conditions
  - Current product is non-GMO
- Approved for use in the EU
  - >10 years of safety data in salmon farming
  - Safety studies completed in pigs, chickens, calves, rats, mink, and fox
- Product is analogous to yeast extract
  - No corn fiber residue: provides a concentrated protein product
- Supplied dry as powder or pellets; shelf-life >12 months at ambient temperature
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Menlo Park, CA – June 16, 2014 – Calysta, Inc. (www.calysta.com) today announced it has successfully fermented methane into lactic acid, under a research collaboration with NatureWorks. Lactic acid is the building block for NatureWorks Ingeo™ lactide intermediates and polymers used in consumer and industrial products worldwide. The joint development program, started in June 2013 between Calysta and NatureWorks, is focused on creation of a commercially viable methane-to-lactic-acid process. The key aims are providing a structurally simplified, lower cost Ingeo production platform and diversifying NatureWorks’ feedstock portfolio.
DOE AWARDS $2.5 MILLION TO NATUREWORKS TO TRANSFORM BIOGAS INTO THE LACTIC ACID BUILDING BLOCK FOR INGEO

MINNETONKA, Minn., October 30, 2014 -- The U.S. Energy Department’s Office of Energy Efficiency and Renewable Energy, Bioenergy Technologies announced a grant of up to $2.5 million to NatureWorks, one of the world’s leading suppliers of bioplastics, in support of an ongoing program that aims to sequester and use methane, a potent greenhouse gas, as a feedstock for the company’s Ingeo™ biopolymers and intermediates.
Calysta Continues to Lead with Innovative Uses for Methane

• Calysta’s progress in the last year has changed the face of the company
• Fully integrated lab-to-commercial platform
• Commercial plant siting is underway; construction to begin next year

Building a sustainable platform to food, fuels, and chemicals from an abundant resource that represents a practical solution